CHEMICALS
Project Fact Sheet

Energy-Saving Method for Producing Ethylene Glycol and Propylene Glycol

Innovative new process reduces excess water and energy requirements during glycol production

Benefits
- Saves energy required for distillation of excess water
- Reduces glycol manufacturing water use by 780 million gallons per year
- Increases reaction rate, allowing for greater production output and decreased equipment size requirements
- Offers high selectivity in production of mono-ethylene glycol
- Eliminates need for catalyst separation from glycol product
- Allows low, near-ambient temperature reaction

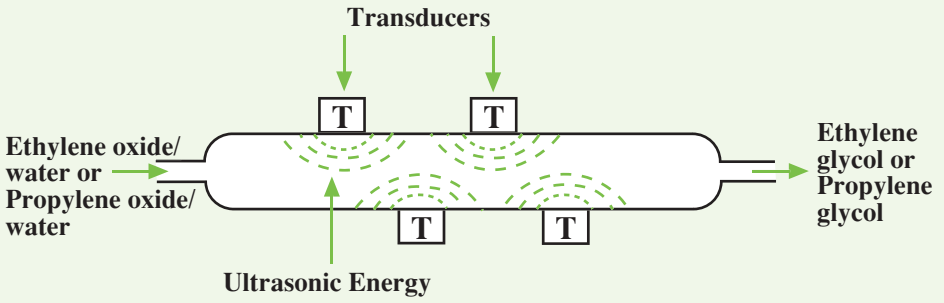
Applications
The energy-saving method for producing ethylene glycol and propylene glycol is applicable for glycol manufacturers opening new production facilities, expanding existing capacity, or revamping older facilities. This new technology may also be applicable to other chemical production processes.

Each year, massive quantities of ethylene glycol and propylene glycol are produced in the United States. The industrial method for glycol production involves hydrolysis of the corresponding alkylene oxide (epoxide) in the presence of excess water at elevated temperature and pressure. Fifteen to twenty-fold excess water is used to minimize formation of undesirable compounds, and only one equivalent of water is consumed by the hydrolysis reaction. Remaining equivalents of water must later be removed from the glycol by distillation. For each pound of ethylene glycol produced, 5.5 pounds of excess water is removed during purification, amounting to 4 billion gallons of water per year in the United States and energy consumption of 32 trillion Btu.

A new energy-saving method for producing ethylene glycol and propylene glycol uses only two excess equivalents of water. The process uses a heterogeneously catalyzed hydrolysis of ethylene oxide and propylene oxide that offers high selectivity. While other heterogeneously catalyzed methods for producing ethylene glycol with low water and epoxide ratios have been too slow to be commercially competitive, this new method speeds the reactions with the sonochemical effects of ultrasound.

Project Description
Goal: Develop and demonstrate a new process capable of reducing the energy and excess water requirements in glycol production.

Ultrasonic Reactor for Glycol Production



By employing ultrasound technology to enhance reaction rates, the energy-saving method for producing ethylene and propylene glycol increases glycol production while reducing energy use and lowering capital costs.

The new process combines two proven technologies – a heterogeneous hydrolysis catalyst and sonochemistry – in the production of glycols. The process employs a highly selective, heterogeneous catalyst for the production of mono-ethylene glycol, requires comparatively little water for reaction, and does not subsequently have to be separated from the glycol product. Heterogeneous catalysts have previously been tested successfully in laboratories, but reaction rates were too slow for commercial use.

Sonochemistry provides a unique enhancement to the reaction rate and selectivity in heterogeneous reaction systems. By using an ultrasound transducer in a small-scale reactor with the heterogeneous catalyst, the sonochemical effect enhances the rate of glycol formation. Sonochemical enhancement of the reaction rate may potentially increase glycol production while using significantly less water in smaller-size reactors, resulting in reduced energy usage and lower capital costs.

Gallatin Research is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Design and construct a continuous-flow microreactor for reaction optimization studies.
- Determine which heterogeneous catalysts have the highest catalytic activity by conducting test reactions.
- Run an ultrasonic continuous-flow reactor using the best catalyst found in test reactions.
- Prepare market assessment of glycol industry to estimate market share that the technology could capture.
- The developer is working closely with a commercialization partner to prove the concept and feasibility of the process and subsequently move it to the pilot-plant stage.

Economic and Commercial Potential

The potential for cost, energy, and environmental savings associated with the energy-saving method for producing ethylene glycol and propylene glycol is substantial. Approximately 6 billion pounds of ethylene glycol and 1 billion pounds of propylene glycol are produced annually in the United States. At current market prices, these production levels represent $1.2 billion and $670 million markets, respectively.

Current water-hydrolysis methods of ethylene glycol production require 6,000 Btu per pound of glycol. Much of this energy is used to vaporize the 5.5 pounds of excess water that must be distilled from each pound of glycol during purification. In total, 4 billion gallons of water and 32 trillion Btu are required annually in the processing of glycol. The new technology, which uses only two excess equivalents of water, could save 6.3 trillion Btu of energy and 780 million gallons of water annually by capturing a 20 percent market share of glycol production.

Although other processes have been developed for producing ethylene glycol with low water and epoxide ratios and high selectivity, none are commercially competitive. The energy-saving method for producing ethylene glycol and propylene glycol, which employs ultrasound to enhance reaction rates, may offer the potential to increase glycol production.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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